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Bescheinigung

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Attestation

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The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. **Patent application No.** **Demande de brevet n°**

00402939.3

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

I.L.C. HATTEN-HECKMAN

DEN HAAG, DEN
THE HAGUE, 16/07/01
LA HAYE, LE

EPA/EPO/OEB Form 1014 - 02.91

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Blatt 2 der Bescheinigung
Sheet 2 of the certificate
Page 2 de l'attestation

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Demande n°:

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Demandeur(s):
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NETHERLANDS

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Method of transcoding and transcoding device with embedded filters

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Method of transcoding and transcoding device with embedded filters

FIELD OF THE INVENTION

The present invention relates to a method of transcoding a primary encoded signal comprising a sequence of pictures, into a secondary encoded signal, said method of transcoding comprising at least a step of decoding a current picture of the primary encoded signal for providing a first transformed signal, an encoding step, following the decoding step, for obtaining the secondary encoded signal, and a step of predicting a transformed motion compensated signal from a transformed encoding error derived from the encoding step, said prediction step being located between the encoding and decoding steps. The invention also relates to a corresponding device for carrying out such a method of transcoding.

This invention is particularly relevant for the transcoding of MPEG encoded video signals.

BACKGROUND OF THE INVENTION

Bit-rate transcoding is a technique which allows a primary video stream encoded at a bit-rate BR1 to be converted into a secondary video stream encoded at a bit-rate BR2 lower than BR1, the bit-rate reduction being performed in order to meet requirements imposed by the means of transport during broadcasting. A transcoding device as described in the opening paragraph is disclosed in the European Patent Application n° EP 0690 392 (PHF 94001) and is depicted in Fig. 1. Said device (100) for transcoding encoded digital signals (S1) which are representative of a sequence of images, comprises a decoding channel (11,12) followed by an encoding channel (13,14,15). A prediction channel is connected in cascade between these two channels, and said prediction channel comprises, in series, between two subtractors (101,102), an inverse discrete cosine transform sub-assembly IDCT (16), a picture memory MEM (17), a circuit MC (18) for motion compensation in view of displacement vectors (V) which are representative of the motion of each image, and a discrete cosine transform sub-assembly DCT (19).

SUMMARY OF THE INVENTION

It is an object of the invention to provide a method of transcoding and a corresponding device that allows a better quality of pictures for low bit-rate applications. The present invention takes the following aspect into consideration.

With the advent of home digital video recording of MPEG broadcasts, transcoders can be used in consumer devices to implement long play modes or to guarantee the recording time. However, the input signal to be transcoded has often been encoded at a

variable bit-rate with a low average bit-rate. This is due to the generalisation of statistical multiplexing that allows broadcasters to put a lot of video programs in a multiplex in order to save the bandwidth. It is likely that a coarser re-quantisation of the input signal, using a method of transcoding according to the prior art, will lead to conspicuous quantisation artefacts. As a consequence, such a transcoding method is not adapted for low bit-rate applications.

To overcome this drawback, the method of transcoding in accordance with the invention is characterised in that it comprises a filtering step, between the decoding and encoding steps, for providing a filtered transformed signal, and the prediction step further comprises :

- an adding sub-step for determining a sum of the transformed motion compensated signal and a transformed signal, and
- a subtracting sub-step for determining the transformed encoding error from a difference between said sum and a second transformed signal provided by the encoding step.

The transcoding method in accordance with the invention allows to implement filters in the transcoder of the prior art at a negligible cost. Those filters can be tuned to control the static and dynamic resolution and also to perform noise reduction. For the same number of bits, the filtered transformed signal is encoded with a smaller quantisation scale thus reducing visual artefacts such as blocking, ringing and mosquito noise.

In a first embodiment of the invention, the adding sub-step is intended to provide the sum of the transformed motion compensated signal and the first transformed signal, and the filtering step is a temporal filtering step for receiving said sum and for providing the filtered transformed signal to the encoding step. Such a temporal filtering step allows to perform noise reduction using, for example, a recursive filter. As a consequence, bits are only spent on the useful information and the picture quality is thus increased.

In another embodiment of the invention, the filtering step is a spatial filtering step for receiving the first transformed signal, and the adding sub-step is intended to provide the sum of the transformed motion compensated signal and the filtered transformed signal to the encoding step. Such a spatial filtering allows a reduction of the sharpness of the picture and decreases the possible source of ringing and mosquito noise.

The present invention also relates to a corresponding device for carrying out such a method of transcoding.

The present invention finally relates to a computer program product for a receiver, such as a digital video recorder or a set-top-box, that comprises a set of instructions, which, when loaded into the receiver causes the receiver to carry out the method of transcoding.

These and other aspects of the invention will be apparent from and will be elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described in more detail, by way of example, with reference to the accompanying drawings, wherein :

- Fig. 1 is a block diagram corresponding to a transcoding device according to the prior art,
- Fig. 2 is a block diagram corresponding to a first embodiment of a transcoding device according to the invention, said device comprising a temporal filter,
- Fig. 3 is a block diagram corresponding to a second embodiment of a transcoding device according to the invention, said device comprising a spatial filter, and
- Fig. 4 a block diagram corresponding to a third embodiment of a transcoding device according to the invention, said device also comprising a spatial filter.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to an improved method of and a corresponding device for transcoding video encoded signals. It relates, more especially, to MPEG-2 encoded signals but it will be apparent to a person skilled in the art that said method of transcoding stays also applicable to any type of video signals encoded using a block-based technique such as, for example, those provided by MPEG-1, MPEG-4, H-261 or H-263 standards.

A transcoding device allows a primary encoded signal (S1) previously encoded with a first quantisation scale and comprising a sequence of pictures, to be converted into a secondary encoded signal (S2) encoded with a second quantisation scale.

Such a transcoding device comprises at least the following elements :

- a decoding sub-assembly comprising a variable length decoder VLD and a first dequantiser IQ for decoding a current picture of the primary encoded signal and for providing a first transformed signal,
- an encoding sub-assembly comprising a quantiser Q, a variable length encoder VLC for obtaining the secondary encoded signal, and a second dequantiser IQ,
- a prediction sub-assembly, between the encoding sub-assembly and the decoding sub-assembly, and comprising in series :
  - an inverse discrete transform sub-assembly IDCT (an Inverse Discrete Cosine Transform in the case of MPEG),
  - a picture memory MEM,
  - a circuit MC for motion compensation in view of displacement vectors which are representative of the motion of each picture,

- a discrete transform sub-assembly DCT for predicting a transformed motion compensated signal (Rmc) from a transformed encoding error (Re) derived from the encoding sub-assembly,
- an adder for determining a sum of the transformed motion compensated signal and a transformed signal,
- a subtractor for determining the transformed encoding error from a difference between said sum and a second transformed signal (R2) provided by the encoding sub-assembly,

- a filter, between the decoding sub-assembly and the encoding sub-assembly, for providing a filtered transformed signal (Rf).

Said filter can be a temporal or a spatial filter intended to control the static and dynamic resolution and to perform noise reduction on a picture. The different implementations of such filters are described in the following Figs. 2 to 4.

In a first embodiment of the invention, the transcoder implements a motion compensated temporal filter. Temporal filtering allows to reduce signals which are not correlated from frame to frame. It can very effectively reduce noise when combined with motion compensation, as motion compensation tries to correlate the image content from frame to frame. In this embodiment, a recursive filter is implemented since it provides a better selectivity at lower cost.

A naive transcoding chain with a motion compensated recursive temporal filter usually comprises in cascade :

- a decoder for providing motion compensated blocks D1 of decoded pictures from an input stream,
- a recursive temporal filter for providing filtered blocks Df of decoded pictures, and
- an encoder for providing an output stream and motion compensated blocks D2 of locally decoded pictures after encoding.

To reduce costs, the motion compensation in the encoder is re-used in the recursive temporal filter. Thus, the signal D2 is fed back to said filter instead of Df. The filtering equation of a motion compensated block Df(n,m) is then :

$$Df(n,m) = (1-\alpha)\cdot D1(n,m) + \alpha \cdot MC(D2(p(n)), V(n,m)), \qquad (1)$$

where :

- n is the index of the current picture,
- m is the index of a block of said current picture,
- V(n,m) is the motion associated with block m, of picture n,
- p(n) is the index of the anchor picture associated with image n,
- MC is the motion compensation operator, and

- α is a positive scalar smaller than one that tunes the filter response.

An expression similar to equation (1) can be drawn for bi-directional motion compensation. However, without loss of generality, we shall restrict the demonstration to the unidirectional case. Note that intra encoded blocks cannot be filtered since no prediction is formed for them. Yet, intra encoded blocks in non intra pictures correspond most often to newly exposed regions that could not possibly be temporally filtered.

The naive transcoding chain can be simplified using the hypothesis that the motion compensation information is unchanged. To this end, the motion compensated block D1(n,m) is expressed as follows :

$$D1(n,m) = M^t \cdot R1(n,m) \cdot M + MC(D1(p(n)), V(n,m)), \qquad (2)$$

where :

- M is the 8 x 8 discrete cosine transform matrix,
- M^t is the corresponding transposed matrix, and
- R1(n,m) is the residue retrieved from the input bit-stream after variable length decoding VLC and dequantisation IQ.

M is defined by equation (3) and is such that $MM^t = I$:

$$M_{i,j} = \begin{cases} \sqrt{2}/4 & \text{if } i = 0, \\ \cos(i\pi(2j+1)/16)/2 & \text{otherwise.} \end{cases} \qquad (3)$$

Then, the filtered block is encoded using the same motion compensation information. Let Rf(n,m) be the corresponding residue :

$$Rf(n,m) = M \cdot Df(n,m) \cdot M^t - M \cdot MC(D2(p(n)), V(n,m)) \cdot M^t . \qquad (4)$$

The residue is then quantised and dequantised again to compute the locally decoded pictures D2. Let R2(n,m) be the quantised and dequantised residue :

$$R2(n,m) = M \cdot D2(n,m) \cdot M^t - M \cdot MC(D2(p(n)), V(n,m)) \cdot M^t . \qquad (5)$$

The equations (1) and (4) are combined so that Rf is derived directly from D1 and D2 :

$$Rf(n,m) = (1-\alpha)\left[M \cdot D1(n,m) \cdot M^t - M \cdot MC(D2(p(n)), V(n,m)) \cdot M^t\right]. \qquad (6)$$

Combining the equation (2) with equation (6) gives :

$$Rf(n,m) = (1-\alpha)\left[R1(n,m) + M \cdot MC(D1(p(n)), V(n,m)) \cdot M^t - M \cdot MC(D2(p(n)), V(n,m)) \cdot M^t\right]. \qquad (7)$$

Since motion compensation is performed identically from D1 and from D2, the motion compensation operator MC can operate on the picture difference, i.e., on the error signal due to the transcoding operation. Defining δD = D1 - D2, equation (7) is rewritten as follows :

$$Rf(n,m) = (1-\alpha)\left[R1(n,m) + M \cdot MC(\delta D(p(n)), V(n,m)) \cdot M^t\right]. \tag{8}$$

The error signal δD can be derived from the prediction errors, combining equations (5) and (6) :

$$\delta D(n,m) = M^t\left[\frac{Rf(n,m)}{1-\alpha} - R2(n,m)\right] \cdot M. \tag{9}$$

Equations (8) and (9) define the transcoder structure depicted in Fig. 2. Said transcoder (200) comprises :

- a decoding channel comprising a variable length decoder VLD (11) and a first dequantiser IQ (12) for decoding a current picture of a primary encoded signal (S1) and for providing a first transformed signal (R1),
- an encoding channel comprising a quantiser Q (13), a variable length encoder VLC (14) for obtaining the secondary encoded signal (S2), and a second dequantiser IQ (15) for providing a second transformed signal (R2),
- a prediction channel comprising, in series :
  - a subtractor (201) for determining a transformed encoding error (Re) and whose negative input receives the second transformed signal,
  - an inverse discrete cosine transform IDCT (16),
  - a picture memory MEM (17),
  - a circuit MC (18) for motion compensation,
  - a discrete cosine transform DCT (19) for predicting a transformed motion compensated signal (Rmc),
  - an adder (202) for providing a sum of the transformed motion compensated signal and the first transformed signal (R1) to the positive input of the subtractor,
- a temporal filter W (21) for receiving said sum and for providing the filtered transformed signal (Rf) to the quantiser Q (13).

The strength of the motion compensated recursive temporal filter can be adjusted separately for each transformed coefficient Rf[i], i.e., for each DCT sub-band. The transformed coefficient of rank i is multiplied by $W[i] = 1 - \alpha[i]$ such as :

$$Rf[i] = W[i]\,(R1[i] + Rmc[i]) \tag{10}$$

Thus, the noise reduction can be tuned to the spectral shape of the noise. It can also be decided not to filter low frequencies in order to avoid visible artefact in case of a bad motion compensation and to reduce the noise.

In the second and third embodiments of the invention, the transcoder implements a spatial filter. Spatial filtering is not so efficient to reduce the noise as motion compensated temporal filtering is. Yet, it can prevent block artefacts at low bit-rate, smoothing down sharp edges that would otherwise create ringing effects. It can also simplify complex

patterns that would be otherwise randomly distorted from one picture to the other, resulting in the so-called mosquito noise.

Let us consider again the naive transcoding chain. The pixel domain filter shall have the same granularity that the granularity of the decoder. Thus we consider a block-wise filter. Let D1(n,m) be block m of picture n. The filtered block D1(n,m) is computed as follows :

$$Df(n,m) = Fv(n) \cdot D1(n,m) \cdot Fh^t(n) \tag{11}$$

where Fv(n) and Fh(n) are matrices that define respectively the vertical and horizontal filtering within the block.

Combining the equation (11) with the equation (2), we find :

$$\begin{aligned} Df(n,m) = {} & Fv(n) \cdot M^t \cdot R1(n,m) \cdot M \cdot Fh^t(n) \\ & + Fv(n) \cdot MC(D1(p(n)), V(n,m)) \cdot Fh^t(n) \end{aligned} \tag{12}$$

If the filter is the same for a group of pictures, then Fv(n) = Fv(p(n)) and Fh(n) = Fh(p(n)). Thus, the following approximation can be given for equation (12) based on the assumption that block-wise filtering commutes with motion compensation :

$$Df(n,m) = Fv(n) \cdot M^t \cdot R1(n,m) \cdot M \cdot Fh^t(n) + MC(Df(p(n)), V(n,m)) \tag{13}$$

It follows that the block-wise filter can be applied to residue R1(n,m) after an inverse discrete cosine transform IDCT. To implement the spatial filter in the transcoder, the residue R1(n,m) needs to be substituted by :

$$Rf(n,m) = M \cdot Fv(n) \cdot M^t \cdot R1(n,m) \cdot M \cdot Fh^t(n) \cdot M^t \tag{14}$$

Even if the matrices $M \cdot Fv(n) \cdot M^t$ and $M \cdot Fh^t(n) \cdot M^t$ can be pre-computed, their computing seems to involve many operations. Said computing can be simplified for a class of block-wise filters for which the two matrices are diagonal. Such filters are symmetric filters with an even number of taps. In our embodiment, we consider normalised 3-tap symmetric filters since they are more suitable for small blocks. Such filters have a single parameter, denoted a. The corresponding pixel domain filtering matrix, $(F_{i,j})_{0 \le i,j < 8}$, is defined by :

$$F_{i,j} = \frac{1}{2+a} \begin{cases} a & \text{for } i = j = 1 \text{ to } 6, \\ 1 & \text{for } i = j \pm 1, \\ 1+a & \text{for } i = j = 0 \text{ and } 7, \\ 0 & \text{otherwise.} \end{cases} \tag{15}$$

Then,

$$M \cdot F_{i,j} \cdot M^t = \frac{1}{2+a} \begin{cases} 2\cos(i\pi/8) + a & \text{for } i = j \\ 0 & \text{otherwise.} \end{cases} \tag{16}$$

Thus, to implement filtering with horizontal parameter a_h and vertical parameter a_v, the residue R1(n,m) needs to be weighted (component-wise) by $(W_{i,j})_{0\leq i,j<8}$ defined as follows :

$$W_{i,j} = \frac{2\cos(i\pi/8)+a_v}{2+a_v} \cdot \frac{2\cos(j\pi/8)+a_h}{2+a_h} \qquad (17)$$

Fig. 3 shows a transcoder with spatial pre-filtering according to the second embodiment of the invention. Said transcoder (300) comprises :

- a decoding channel comprising a variable length decoder VLD (11) and a first dequantiser IQ (12) for providing a first transformed signal (R1),
- a spatial filter W (31) for receiving said first transformed signal and for providing the filtered transformed signal (Rf),
- an encoding channel comprising a quantiser Q (13), a variable length encoder VLC (14) and a second dequantiser IQ (15) for providing a second transformed signal (R2),
- a prediction channel comprising, in series :
  - a subtractor (201) for determining a transformed encoding error (Re) and whose negative input receives the second transformed signal,
  - an inverse discrete cosine transform IDCT (16),
  - a picture memory MEM (17),
  - a circuit MC (18) for motion compensation,
  - a discrete cosine transform DCT (19) for predicting a transformed motion compensated signal (Rmc), and
  - an adder (302) for providing a sum of said transformed motion compensated signal and the filtered transformed signal (Rf) to the positive input of the subtractor.

Fig. 4 is a transcoder according to the third embodiment of the invention, with spatial post-filtering whose weighting factors are $W_{i,j}$. Said transcoder (400) comprises :

- a decoding channel (11,12) for providing a first transformed signal (R1),
- an encoding channel (13,14,15) further comprising an inverse filter (42) for providing a second transformed signal (R2),
- a prediction channel comprising, in series :
  - a subtractor (201) for determining a transformed encoding error (Re) and whose negative input receives the second transformed signal,
  - an inverse discrete cosine transform IDCT (16),
  - a picture memory MEM (17),
  - a circuit MC (18) for motion compensation,
  - a discrete cosine transform DCT (19) for predicting a transformed motion compensated signal (Rmc),

- an adder (202) for providing a sum of said transformed motion compensated signal and the first transformed signal (R1) to the positive input of the subtractor, and

- a spatial filter W (41) for receiving said sum and for providing a filtered transformed signal (Rf) to the encoding channel.

Compared to pre-filtering, the spatial filter is performed in the encoding part of the transcoder.

In such transcoders (200,300,400), the filter is performed on the dequantised data which results in a better accuracy. Best results, so far, were obtained for the combination of spatial filtering of pictures and temporal filtering of predicted pictures. Successive filtering blocks W can also be merged into a single block whose weighting is the product of the individual weightings without departing from the scope of the invention.

The drawings and their description hereinbefore refer both to a transcoding device and a method of transcoding, a functional block of a diagram corresponding to a sub-assembly of said device or a step of said method, respectively. They illustrate rather than limit the invention. It will be evident that there are numerous alternatives, which fall within the scope of the appended claims. In this respect, the following closing remarks are made.

There are numerous ways of implementing functions by means of items of hardware or software, or both. In this respect, the drawings of Fig. 2 to 4 are very diagrammatic, each representing only one possible embodiment of the invention. Thus, although a drawing shows different functions as different blocks, this by no means excludes that a single item of hardware or software carries out several functions. Nor does it exclude that an assembly of items of hardware or software or both carry out a function. For example, the filtering step can be combined with the quantisation step, thus forming a single step without modifying the method of transcoding in accordance with the invention.

Said method of transcoding can be implemented in several manners, such as by means of wired electronic circuits or, alternatively, by means of a set of instructions stored in a computer-readable medium, said instructions replacing at least a part of said circuits and being executable under the control of a computer or a digital processor in order to carry out the same functions as fulfilled in said replaced circuits.

Any reference sign in the following claims should not be construed as limiting the claim. It will be obvious that the use of the verb "to comprise" and its conjugations does not exclude the presence of any other steps or elements besides those defined in any claim. The word "a" or "an" preceding an element or step does not exclude the presence of a plurality of such elements or steps.

CLAIMS

1 A method of transcoding a primary encoded signal (S1) comprising a sequence of pictures, into a secondary encoded signal (S2), said transcoding method comprising at least the steps of :

- decoding (11,12) a current picture of the primary encoded signal for providing a first transformed signal (R1),
- encoding (13,14,15), following the decoding step, for obtaining the secondary encoded signal,
- predicting (16,17,18,19) a transformed motion compensated signal (Rmc) from a transformed encoding error (Re) derived from the encoding step, said prediction step being located between the encoding and decoding steps,

characterised in that said method of transcoding further comprises a filtering step, between the decoding and encoding steps, for providing a filtered transformed signal (Rf), and the prediction step further comprises :

- an adding sub-step for determining a sum of the transformed motion compensated signal and a transformed signal, and
- a subtracting sub-step (201) for determining the transformed encoding error from a difference between said sum and a second transformed signal (R2) provided by the encoding step.

2 A method of transcoding as claimed in claim 1, characterised in that :

- the adding sub-step (202) is intended to provide the sum of the transformed motion compensated signal (Rmc) and the first transformed signal (R1), and
- the filtering step is a temporal filtering step (21) for receiving said sum and for providing the filtered transformed signal (Rf) to the encoding step (13,14,15).

3 A method of transcoding as claimed in claim 2, characterised in that the temporal filtering step (21) is intended to use a recursive filter such as $Rf[i] = (1 - \alpha[i]) (R1[i] + Rmc[i])$ where $Rf[i]$, $R1[i]$ and $Rmc[i]$ are transformed coefficients comprised in the transformed signals (Rf,R1,Rmc) and $\alpha[i]$ is a filter coefficient comprised between 0 and 1.

4 A method of transcoding as claimed in claim 1, characterised in that :

- the filtering step is a spatial filtering step (31) for receiving the first transformed signal (R1), and
- the adding sub-step (302) is intended to provide the sum of the transformed motion compensated signal (Rmc) and the filtered transformed signal (Rf) to the encoding step (13,14,15).

5 A method of transcoding as claimed in claim 1, characterised in that :

- the adding sub-step (202) is intended to provide the sum of the transformed motion compensated signal (Rmc) and the first transformed signal (R1),
- the filtering step is a spatial filtering step (41) for receiving said sum and for providing the filtered transformed signal (Rf) to the encoding step (13,14,15), and
- said encoding step further comprises an inverse filtering sub-step (42) for providing the second transformed signal (R2).

6 A device for transcoding a primary encoded signal (S1) comprising a sequence of pictures, into a secondary encoded signal (S2), said device comprising at least :
- a decoding sub-assembly (11,12) for decoding a current picture of the primary encoded signal and providing a first transformed signal (R1),
- an encoding sub-assembly (13,14,15) for obtaining the secondary encoded signal,
- a prediction sub-assembly (16,17,18,19) for predicting a transformed motion compensated signal (Rmc) from a transformed encoding error (Re) derived from the encoding sub-assembly, said prediction sub-assembly being located between the encoding sub-assembly and the decoding sub-assembly,

characterised in that said transcoding device further comprises a filter, between the decoding sub-assembly and the encoding sub-assembly, for providing a filtered transformed signal (Rf), and the prediction sub-assembly further comprises :
- an adder for determining a sum of the transformed motion compensated signal and a transformed signal, and
- a subtractor (201) for determining the transformed encoding error from a difference between said sum and a second transformed signal (R2) provided by said encoding sub-assembly.

7 A transcoding device as claimed in claim 6, characterised in that :
- the adder (202) is intended to provide the sum of the transformed motion compensated signal (Rmc) and the first transformed signal (R1), and
- the filter is a temporal filter (21) for receiving said sum and for providing the filtered transformed signal (Rf) to the encoding sub-assembly (13,14,15).

8 A transcoding device as claimed in claim 6, characterised in that :
- the filter is a spatial filter (31) for receiving the first transformed signal (R1), and
- the adder (302) is intended to provide the sum of the transformed motion compensated signal (Rmc) and the filtered transformed signal (Rf) to the encoding sub-assembly (13,14,15).

9 A transcoding device as claimed in claim 6, characterised in that :

- the adder (202) is intended to provide the sum of the transformed motion compensated signal (Rmc) and the first transformed signal (R1),
- the filter is a spatial filter (41) for receiving said sum and for providing the filtered transformed signal (Rf) to the encoding sub-assembly (13,14,15), and
- said encoding sub-assembly further comprises an inverse filter (42) for providing the second transformed signal (R2).

10 A computer program product for a digital video recorder that comprises a set of instructions, which, when loaded into said digital video recorder, causes the digital video recorder to carry out the method as claimed in claim 1 to 5.

11 A computer program product for a set-top-box that comprises a set of instructions, which, when loaded into said set-top-box, causes the set-top-box to carry out the method as claimed in claim 1 to 5.

Method of transcoding and transcoding device with embedded filters

ABSTRACT

The present invention relates to a method of and a corresponding device (200) for transcoding a primary encoded signal (S1) into a secondary encoded signal (S2). Said method of transcoding comprises a step of decoding (11,12) the primary encoded signal for providing a first transformed signal (R1), an encoding step (13,14,15) following the decoding step, and a step of predicting (16,17,18,19) a transformed motion compensated signal (Rmc), located between the encoding and decoding steps. Said method of transcoding further comprises a filtering step (21), between the decoding and encoding steps, the prediction step thus comprising an adding sub-step (202) for determining a sum of the transformed motion compensated signal and the first transformed signal, and a subtracting sub-step (201) for determining a transformed encoding error (Re) from a difference between said sum and a second transformed signal (R2) provided by the encoding step. Such a method allows a better quality of pictures for low bit-rate applications.

Use: MPEG transcoders, digital video recorders or set-top-boxes

Reference: Fig. 2

1/2

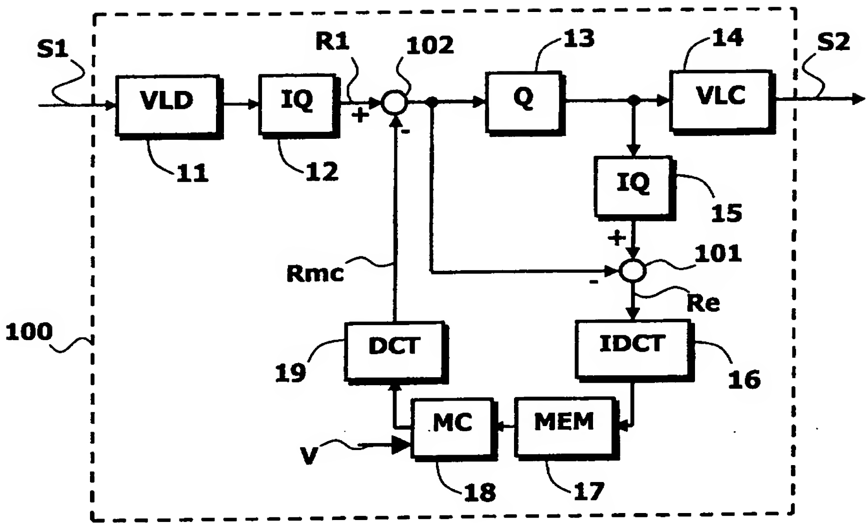
S1
VLD
IQ
R1
102
Q
13
VLC
14
S2
11
12
+
-
IQ
15
+
101
-
Rmc
Re
100
DCT
19
IDCT
16
MC
MEM
V
18
17

FIG. 1

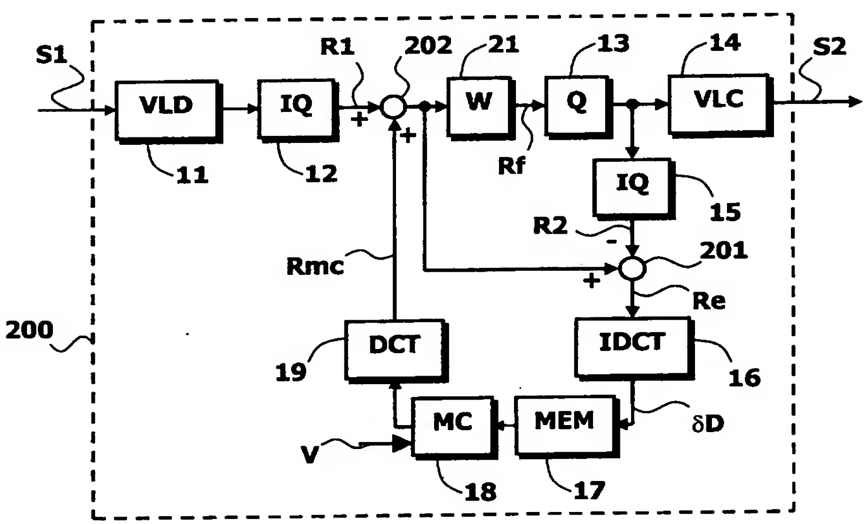
S1
VLD
IQ
R1
202
W
21
Q
13
VLC
14
S2
11
12
+
+
Rf
IQ
15
R2
-
201
+
Rmc
Re
200
DCT
19
IDCT
16
MC
MEM
δD
V
18
17

FIG. 2

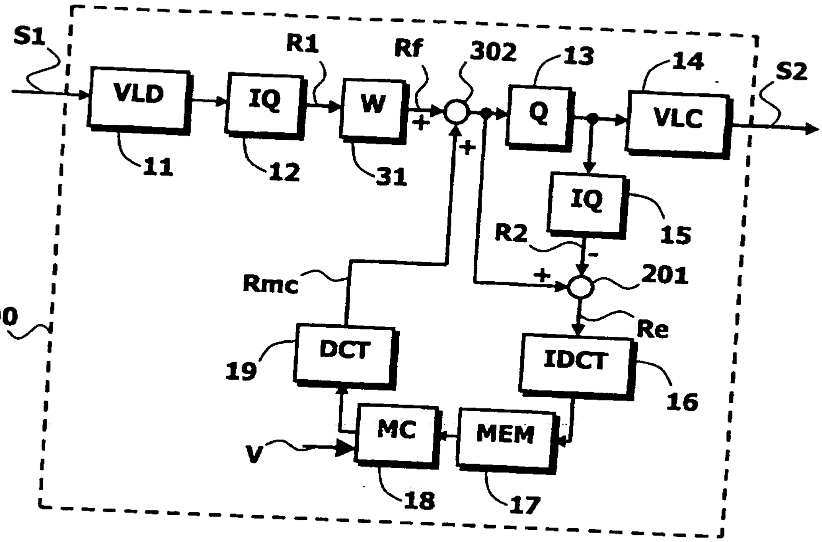
S1
VLD
IQ
W
Q
VLC
S2
R1
Rf
302
13
14
11
12
31
IQ
15
R2
201
Rmc
300
Re
DCT
IDCT
19
16
MC
MEM
V
18
17

FIG. 3

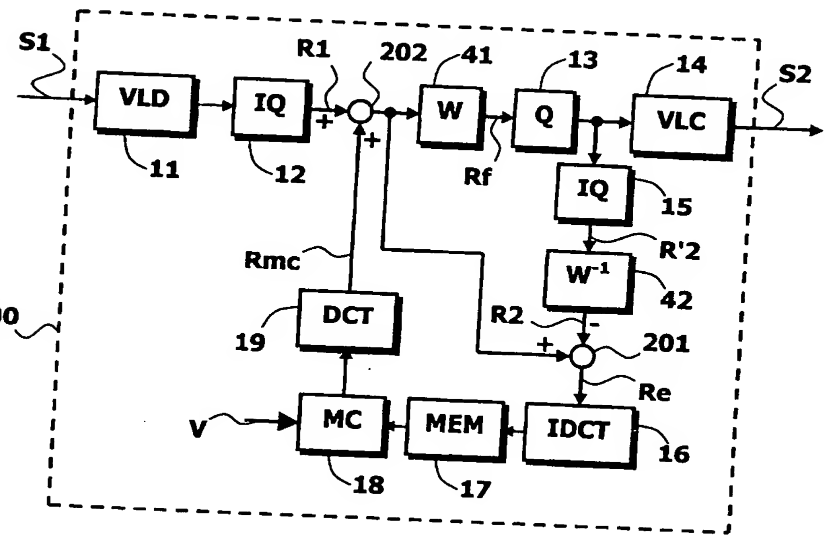
S1
VLD
IQ
W
Q
VLC
S2
R1
202
41
13
14
11
12
Rf
IQ
15
R'2
W⁻¹
42
Rmc
400
DCT
19
R2
201
Re
MC
MEM
IDCT
V
18
17
16

FIG. 4